PATENT ABSTRACTS OF JAPAN

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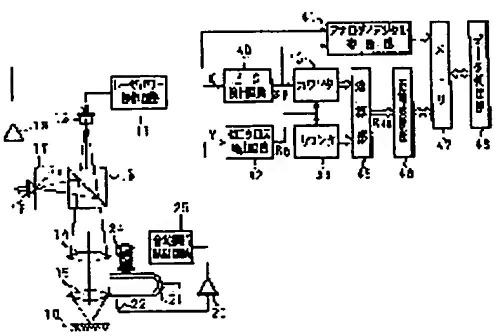
(54) DISPLACEMENT SENSOR



(57)Abstract:

PURPOSE: To correctly measure a surface displacement of a to-be-measured object by providing a memory for storing converted results of an A/D converting part and a distance-converting part and, a data-judging part for judging distance data as measuring data based on the content stored in the memory.

CONSTITUTION: When an objective lens 15 is oscillated in a direction of an optical axis with a predetermined amplitude, the distance between the lens 15 and a to-be-measured object 16 is changed. When the distance of the lens 15 and object 16 becomes a predetermined value, an emitted light is focused on the object 16. Data of a distance to the object 16 are obtained based on a detected output level of a photodetecting part receiving a reflecting light via the lens 15 from a position where the focus is met and a position of the lens 15. The detected output level and distance data are stored in a memory 47. When the maximum value of the detected output. in a half cycle of the oscillation of the lens 15 is not lower than a predetermined level, and the maximum value and a value second large to the maximum value are not smaller than a predetermined value, data corresponding to the maximum value are judged as measuring data at a data judging part 48.

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CLAIMS

[Claim(s)]

[Claim 1] a light-receiving output level of a light sensing portion which projects outgoing radiation light of a light-emitting part to a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through said objective lens characterized by providing the following, and a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- a displacement gage which measures a variation rate The storage section which memorizes said light-receiving output level and said distance data A means to distinguish whether there is any light-receiving output maximum in an oscillating half period of an objective lens read from this storage section more than predetermined level Said light-receiving output maximum A means to distinguish whether a difference with the large light-receiving output following order value is beyond a predetermined value to a degree of light-receiving output maximum, and a means to judge distance data corresponding to light-receiving output maximum to be measurement data when it distinguishes that there is light-receiving output maximum more than predetermined level, and a difference of light-receiving output maximum and the light-receiving output following order value is beyond a predetermined value

[Claim 2] a light-receiving output level of a light sensing portion which projects outgoing radiation light of a light-emitting part on a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through said objective lens characterized by providing the following, and a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- a displacement gage which measures a variation rate The storage section which memorizes said light-receiving output level and said distance data A means to distinguish whether there is any light-receiving output maximum in an oscillating half period of an objective lens read from this storage section more than predetermined level A means to distinguish whether the large light-receiving output following order value is in a degree of light-receiving output maximum more than predetermined level It is a means to judge distance [with a small or numeric value] data with a large numeric value to be measurement data when there were both light-receiving output maximum and a light-receiving output following order value more than predetermined level and it distinguishes.

[Claim 3] a light-receiving output level of a light sensing portion which projects

outgoing radiation light of a light-emitting part on a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through said objective lens characterized by providing the following, and a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- a displacement gage which measures a variation rate The storage section which memorizes said light-receiving output level and said distance data A means to extract a light-receiving output more than predetermined level in an oscillating half period of an objective lens read from this storage section A means by which a numeric value judges the minimum distance data in an extracted light-receiving output and corresponding distance data to be measurement data

[Claim 4] A displacement gage according to claim 1, 2, or 3 constituted by tuning fork which connected an objective lens for said excitation section, and solenoid which drives this tuning fork.

[Claim 5] A displacement gage according to claim 1, 2, or 3 constituted by mounting beam piezoelectric device in said excitation section to a tuning fork which connected an objective lens, and a tuning fork.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the displacement gage which measures the variation rate of the front face of device under tests, such as a metal, resin, and a ceramic.

[0002]

[Description of the Prior Art] The applicant for this patent is doing patent application of the displacement gage which measures the variation rate of the front face of device under tests, such as a metal and resin, by Japanese Patent Application No. No. 257255 [five to]. Drawing 9 is the typical block diagram of this displacement gage. The outgoing radiation light of the laser diode 12 driven by the laser power control circuit 11 carries out sequential passage of a beam splitter 13, and a collimate lens 14 and an objective lens 15, and it is projected on it to a device under test 16. It reflects by the beam splitter 13 through an objective lens 15 and a collimate lens 14, and the reflected light from a device under test 16 is pinhole 17a of the optical converging section 17. It passes and incidence is carried out to photo diode 18.

[0003] The signal by which photo electric translation was carried out with photo diode 18 is amplified with amplifier 19, and the output signal X is inputted into operation part 20. The periphery portion of an objective lens 15 is attached in the 1 side point of the U character-like tuning fork 21. An objective lens 15 is vibrated by oscillation of a tuning fork 21 with the predetermined amplitude in the direction of an optical axis of the outgoing radiation light of a laser diode 12. The tuning fork amplitude detector 22 which consists of a sensor using the MAG, light, or electrostatic capacity is arranged in the side of the 1 side point of a tuning fork 21, and the amplitude of a tuning fork 21, i.e., the location of an objective lens 15, is detected.

[0004] The detection amplitude signal which the tuning fork amplitude detector 22 detected is inputted into amplifier 23, and the output signal Y is inputted into operation part 20. The solenoid 24 for vibrating a tuning fork 21 is arranged in the side of a side point besides a tuning fork 21. The control current from the tuning fork amplitude-control circuit 25 is supplied, and the output signal of amplifier 23 is given to the tuning fork amplitude-control circuit 25, and it is controlled by the solenoid 24 in order to make the amplitude of a tuning fork 21 uniformly. The displacement signal outputted by catching by operation part 20 is inputted into the distance transform section 50.

[0005] Drawing 10 is the block diagram showing the configuration of operation part 20. The output signal X from amplifier 19 is inputted into a differentiator 30 and plus input terminal + of the 1st comparator 31. In negative input terminal - of a comparator 31, it is reference voltage Vref. It is inputted. The output signal S30 of a differentiator 30 is inputted into negative input terminal - of the 2nd comparator 32. Plus input terminal + of a comparator 32 is grounded. Comparators 31 and 32 An output signal S31 and S32 are AND. 1 of a circuit 33, It is inputted into other input terminals at each **, and the output signal S33 is inputted into the single shot pulse generating circuit 34. The single shot pulse S34 which the single shot pulse generating circuit 34 outputs is given as ON and an off control signal to a switching circuit SW. amplifier 23 (refer to drawing 9) from -- an output signal Y is inputted into amplifier 36 through amplifier 35 and a switching circuit SW. The input side of amplifier 36 is grounded through a capacitor 37. A sample hold circuit 38 is constituted by amplifier 36 and the capacitor 37, and the displacement signal S38 is outputted from amplifier 36.

[0006] Next, actuation of this displacement gage is explained. If current is supplied to a solenoid 24 from the tuning fork amplitude-control circuit 25, a magnetic field will occur by the solenoid 24, electromagnetic force acts on a tuning fork 21, a tuning fork 21 vibrates with the predetermined amplitude, and an objective lens 15 vibrates in the direction of an optical axis of the light which passes along it. The tuning fork amplitude detector 22 outputs the sinusoidal signal according to the amplitude of a tuning fork 21, i.e., the amplitude of an objective lens 15. This sinusoidal signal is amplified with amplifier 23, and that output signal Y is inputted into operation part 20.

[0007] On the other hand, if actuation current is supplied to a laser diode 12 from the laser power control circuit 11, a laser diode 12 will carry out outgoing radiation of the laser beam. It is projected on this outgoing radiation light to a device under test 16 through a beam splitter 13, a collimate lens 14, and an objective lens 15. And it reflects by the beam splitter 13 through an objective lens 15 and a collimate lens 14, and the reflected light from a device under test 16 is pinhole 17a. It passes and only the light of the focusing point produced in the device under test 16 carries out incidence to photo diode 18.

[0008] By the way, since the objective lens 15 is vibrating, when the distance of an objective lens 15 and a device under test 16 changes and predetermined distance is reached When the focusing point of the light projected on the device under test 16 arises in a device under test 16, it becomes max in an instant, the signal according

to this light-receiving output is inputted into amplifier 19, and the light-receiving output of photo diode 18 is drawing 11 (a) from amplifier 19. The shown output signal X is outputted and it is inputted into operation part 20. Thus, if output signals X and Y are inputted into operation part 20, an output signal Y will be differentiated with a differentiator 30, and the output signal S30 of the shape of **** reverse S character shown in drawing 11 (b) from a differentiator 30 will be outputted.

[0009] And the maximum of an output signal X is T0 at the zero cross event of an output signal S30. It is detected and the event of the focusing point of the light projected on the device under test 16 arising is detected to accuracy. This output signal S30 is inputted into a comparator 32, a comparator 32 carries out the size comparison of an output signal S30 and the touch-down potential, and it is T0 from a comparator 32 at the zero cross event of an output signal S30. Drawing 11 of the pulse width corresponding to [start and] the period of the negative half period of an output signal S30 (d) The output signal S32 of the shown pulse is outputted.

[0010] On the other hand, a comparator 31 is an output signal X and reference voltage Vref. A size comparison is carried out and an output signal X is reference voltage Vref from a comparator 31. Drawing 11 of the pulse width corresponding to the period which is above (c) The shown output signal S31 is outputted. It is AND if these output signals S31 and the logic of S32 are materialized. A circuit 33 to drawing 11 (e) The output signal S33 of the shown pulse is outputted, and it inputs into the single shot pulse generating circuit 34. Thereby, the single shot pulse generating circuit 34 is drawing 11 (f) which starts synchronizing with the standup of an output signal S33. The shown single shot pulse S34 is outputted, and a switching circuit SW is made to turn on.

[0011] If it does so, the output signal Y of amplifier 35 is inputted into a sample hold circuit 38 through a switching circuit SW, and a sample hold circuit 38 will sample and hold the signal level of an output signal Y, will amplify it with amplifier 35, and will output the displacement signal S38. This will sample the level of the output signal Y at the zero cross event of an output signal S30, i.e., the amplitude of an objective lens 15. And the sampled displacement signal S38 is inputted into the distance transform section 50, the displacement signal S38 is changed into the distance according to the displacement signal S38, and the variation rate of the front face of a device under test 16 is measured.

[0012] Drawing 12 is the timing chart of an output signal Y, the single shot pulse S34, and the displacement signal S38. Location of an objective lens 15 (amplitude) It corresponds and is drawing 12 (a). While the output signal Y was changing so that it may be shown, when the focusing point arose in the device under test 16, it is drawing 12 (b). Generating of the shown single shot pulse S34 samples the level of the output signal Y at the event. And when a device under test 16 is moved in the direction which intersects perpendicularly with an optical axis, it responds to the variation rate of the front face of a device under test 16, and the displacement signal S38 is drawing 12 (a). It changes stair-like so that it may be shown, and the level of the displacement signal S38 and the variation rate of the front face of a device under test 16 correspond. Therefore, if the level of an output signal Y is sampled, according to the level of an output signal Y, the variation rate of a device under

test 16 will be measured to high degree of accuracy.

[0013]

[Problem(s) to be Solved by the Invention] However, if the light projected on the device under test reflects in the inclined plane of the height as shown in drawing 13 when the front face of ** et al. and a device under test serves as the shape of detailed toothing, it will reflect by the beam splitter 13 through the part by the side of the periphery of an objective lens, and the condition that originate in the aberration of an objective lens 15 and focal locations differ will produce the reflected light. Therefore, the half-section of the light projected, for example on the device under test reflects on the front face of a device under test, and in respect of flat. The light reflected in respect of flat when the condition that the remaining half-section reflected in an inclined plane arose the center of an objective lens A passage, From the photo diode which will pass along the part by the side of the periphery of an objective lens, and receives the reflected light by the difference in a focal location, the light reflected in the inclined plane Two pulse signals of few time difference will be outputted, and there is a problem that it cannot distinguish whether the variation rate of the front face of a device under test should be measured by which pulse signal.

[0014] This invention aims at offering the displacement gage which can measure the variation rate of the front face of a device under test to accuracy, even if two pulse signals are outputted by few time difference in view of this problem from the light sensing portion which receives the reflected light from a device under test.

[0015]

[Means for Solving the Problem] A light-receiving output level of a light sensing portion which a displacement gage concerning the 1st invention projects outgoing radiation light of a light-emitting part to a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through said objective lens, a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- with the storage section which is the displacement gage which measures a variation rate and memorizes said light-receiving output level and said distance data A means to distinguish whether there is any light-receiving output maximum in an oscillating half period of an objective lens read from this storage section more than predetermined level, A means to distinguish whether a difference of said light-receiving output maximum and the large light-receiving output following order value to a degree of light-receiving output maximum is beyond a predetermined value, There is light-receiving output maximum more than predetermined level, and when it distinguishes that a difference of light-receiving output maximum and the light-receiving output following order value is beyond a predetermined value, it is characterized by having a means to judge distance data corresponding to light-receiving output maximum to be measurement data.

[0016] A light-receiving output level of a light sensing portion which a displacement gage concerning the 2nd invention projects outgoing radiation light of a light-emitting part on a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through

said objective lens, a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- with the storage section which is the displacement gage which measures a variation rate and memorizes said light-receiving output level and said distance data A means to distinguish whether there is any light-receiving output maximum in an oscillating half period of an objective lens read from this storage section more than predetermined level, A means to distinguish whether the large light-receiving output following order value is in a degree of light-receiving output maximum more than predetermined level, When there were both light-receiving output maximum and a light-receiving output following order value more than predetermined level and it distinguishes, a numeric value is characterized by having a means to judge small or distance data with a large numeric value to be measurement data.

[0017] A light-receiving output level of a light sensing portion which a displacement gage concerning the 3rd invention projects outgoing radiation light of a light-emitting part on a device under test through an objective lens which is vibrating in the direction of an optical axis, and receives the reflected light from a device under test through said objective lens, a location of an objective lens -- being based -- distance data to a device under test -- asking -- a front face of a device under test -- with the storage section which is the displacement gage which measures a variation rate and memorizes said light-receiving output level and said distance data It is characterized by having a means to extract a light-receiving output more than predetermined level in an oscillating half period of an objective lens read from this storage section, and a means by which a numeric value judges the minimum distance data in an extracted light-receiving output and corresponding distance data to be measurement data.

[0018]

[Function] In the 1st invention, if an objective lens is vibrated with the predetermined amplitude in the direction of an optical axis, the distance of an objective lens and a device under test will change. When an objective lens and a device under test reach predetermined distance, the focusing point of the light projected on the device under test arises. Based on the light-receiving output level of a light sensing portion and the location of an objective lens which received the reflected light from the location which the focusing point has produced through the objective lens, the distance data to a device under test is obtained. A light-receiving output level and distance data are memorized in the storage section, the light-receiving output maximum in the oscillating half period of the objective lens read from the storage section is more than predetermined level, and the distance data which corresponds that light-receiving output maximum and the large light-receiving output following order value to the degree of light-receiving output maximum are beyond predetermined values with light-receiving output maximum is judged to be measurement data. Thereby, even if irregular on the surface of a device under test, the variation rate of the front face of a device under test can be measured to accuracy.

[0019] In the 2nd invention, if an objective lens is vibrated with the predetermined amplitude in the direction of an optical axis, the distance of an objective lens and a device under test will change. When an objective lens and a device under test reach predetermined distance, the focusing point of the light projected on the device under

test arises. Based on the light-receiving output level of a light sensing portion, and the location of an objective lens, the distance data to a device under test is obtained through the objective lens which received the reflected light from the location which the focusing point has produced. A light-receiving output level and distance data are memorized in the storage section, and distance [with a small or numeric value] data with a large numeric value is judged with both the large light-receiving output following order values being more than predetermined level to the degree of the light-receiving output maximum in the oscillating half period of an objective lens read from the storage section, and light-receiving output maximum to be measurement data. Thereby, the variation rate of the front face of the device under test of translucency or a base can be measured to accuracy with distance [with a small or numeric value] data with a large numeric value.

[0020] In the 3rd invention, if an objective lens is vibrated with the predetermined amplitude in the direction of an optical axis, the distance of an objective lens and a device under test will change. When an objective lens and a device under test reach predetermined distance, the focusing point of the light projected on the device under test arises. Based on the light-receiving output level of a light sensing portion and the location of an objective lens which received the reflected light from the location which the focusing point has produced through the objective lens, the distance data to a device under test is obtained from the criteria location of optical system. A light-receiving output level and distance data are memorized in the storage section, and the light-receiving output more than predetermined level is extracted among the light-receiving outputs in the half period of the oscillation of an objective lens read from the storage section. A numeric value judges the minimum distance data in the extracted light-receiving output and corresponding distance data to be measurement data. Thereby, the variation rate of the front face of the body of translucency formed in the front face of the body of non-translucency can be measured to accuracy.

[0021]

[Example] This invention is explained in full detail below with the drawing in which the example is shown. Drawing 1 is the typical block diagram of the displacement gage concerning this invention. The outgoing radiation light of the laser diode 12 driven in the laser power control circuit 11 carries out sequential passage of a beam splitter 13, and a collimate lens 14 and an objective lens 15, and it is projected on it by the device under test 16. It reflects by the beam splitter 13 through an objective lens 15 and a collimate lens 14, and the reflected light from a device under test 16 is pinhole 17a. Pinhole 17a of the optical converging section 17 currently formed It passes and incidence is carried out to photo diode 18. Pinhole 17a Magnitude phi is selected in order to make in a minute path as much as possible by the degree type. The wavelength of the light of a phi=0.61x laser diode / NA -- (1), however NA, i.e., numerical aperture, are the constant [0022] shown according to optical system. The signal which carried out photo electric translation with photo diode 18 is inputted into amplifier 19, and the output signal X is inputted into the peak detector 40 and the analog-to-digital-conversion section 41. The periphery portion of an objective lens 15 is attached at the head of 1 side length **** of the tuning fork 21 which carried out the shape of U character. An objective lens 15 is vibrated by oscillation

of a tuning fork 21 with the predetermined amplitude in the direction of an optical axis of the outgoing radiation light of a laser diode 12. The location detecting-element slack tuning fork amplitude detector 22 which consists of a sensor using the MAG, light, or electrostatic capacity is arranged in the side by the side of the head of 1 side length **** of a tuning fork 21, and the amplitude of a tuning fork 21, i.e., the location of an objective lens 15, is detected. The detection amplitude signal which the tuning fork amplitude detector 22 detected is inputted into amplifier 23, and the output signal Y is inputted into the zero cross detector 42. The solenoid 24 for vibrating a tuning fork 21 is arranged in the side by the side of the head of side length **** besides a tuning fork 21.

[0023] The control current from the tuning fork amplitude-control circuit 25 is supplied to a solenoid 24, and it is controlled so that the output signal of amplifier 23 may be given to the tuning fork amplitude-control circuit 25 and it may make the amplitude of a tuning fork 21 uniformly. In addition, for a tuning fork 21, 800Hz and the amplitude are **0.3mm. It vibrates.

[0024] Peak detecting signal SP outputted from the peak detector 40 It is inputted into the 1st counter 43 and analog-to-digital-conversion section 41. Zero cross detecting signal S0 outputted from the zero cross detector 42 It is inputted into a counter 43 and the 2nd counter 44. Counters 43 and 44 Counted value is inputted into operation part 45, and the result-of-an-operation slack phasing signal S45 outputted from operation part 45 is inputted into the distance transform section 46. The distance data changed in the digital value and the distance transform section 46 of an output signal X which were changed in the analog-to-digital-conversion section 41 is memorized to memory 47. The content of storage of memory 47 is inputted into the data judging section 48. The counter 43 is equipped with the latch section and is the peak detecting signal SP. It can latch, whenever it is inputted, and it is the zero cross detecting signal S0. Counted value is cleared. The counter 44 is equipped with the latch section, can latch counted value once, and is the zero cross detecting signal S0. Counted value is cleared.

[0025] Next, about actuation of the displacement gage constituted in this way, they are an output signal Y, the peak value detecting signal SP, and the zero cross detecting signal S0. Drawing 2 which shows a timing chart, and drawing 3 which shows the flow chart of the content of a judgment of the data judging section 48 Drawing 4 It explains with drawing 5 .

[0026] If current is supplied to a solenoid 24 from the tuning fork amplitude-control circuit 25, a magnetic field will occur by the solenoid 24. A tuning fork 21 vibrates with the predetermined amplitude by this generating magnetic field, and an objective lens 15 is vibrated in the direction of an optical axis of the light which passes along it. The tuning fork amplitude detector 22 detects the amplitude of a tuning fork 21, i.e., the amplitude of an objective lens 15, and outputs the amplitude slack sine wave signal of an objective lens 15. This sinusoidal signal is amplified with amplifier 23, and the output signal Y outputted from amplifier 23 is made to input into the zero cross detector 42.

[0027] On the other hand, if actuation current is supplied to a laser diode 12 from the laser power control circuit 11, a laser diode 12 will carry out outgoing radiation

of the laser beam. It is projected on this outgoing radiation light to a device under test 16 through a beam splitter 13, a collimate lens 14, and an objective lens 15. It reflects by the beam splitter 13 through an objective lens 15 and a collimate lens 14, and is projected to the optical converging section 17 side, and the reflected light reflected by the device under test 16 is pinhole 17a. Only a transmitted light carries out incidence to photo diode 18. Therefore, the reflected light by the stray light which was produced in the device under test 16 in photo diode 18, under which it went and which was generated with light and a laser diode 12 is pinhole 17a. It is interrupted and is pinhole 17a. It will not pass but only the light of the focusing point produced in the device under test 16 will carry out incidence to photo diode 18.

[0028] By the way, the signal corresponding [if the point focusing / of the light projected on the device under test 16 when the distance of an objective lens 15 and a device under test 16 changed since the objective lens 15 was vibrated, and predetermined distance was reached / arises in a device under test 16, the light-receiving output of photo diode 18 will serve as max in an instant, and] to this light-receiving output is inputted into amplifier 19, and the output signal X of amplifier 19 is inputted into the peak detector 40.

[0029] Thus, drawing 2 according to the location (amplitude) of an objective lens (a) When the shown output signal Y is inputted into the zero cross detector 42, the zero cross event of an output signal Y is detected, and it is drawing 2 (c) from the zero cross detector 42. Shown zero cross detecting signal S0 It is outputted. Thereby, they are counters 43 and 44. Counted value is cleared, it continues and they are counters 43 and 44. Count actuation is started and time amount is counted. And a counter 44 is the 1st zero cross detecting signal S0. The event of being given to 2nd zero cross detecting signal S0 The time amount t3 of the event of being given, i.e., time amount of one period of an output signal Y, It counts and the counted value is made to latch to the latch section.

[0030] If the output signal X acquired on the other hand when a focusing point arises in a device under test 16 is inputted into the peak detector 40, the peak detector 40 detects the peak value of an output signal X, and is the peak detecting signal SP. It outputs and inputs into a counter 43. Thereby, a counter 43 is the 1st peak detecting signal SP. Counted value t1 of the event of being inputted It is made to latch to the latch section of a counter 43. 2nd [further] peak detecting signal SP Counted value t2 of the event of being inputted It is made to latch to the latch section of a counter 43. Thus, the latched counted value t1, t2, and t3 It inputs into operation part 45. the counted value t1 into which operation part 45 was inputted by that cause, t2, and t3 sin-1 (t1 / t3) -- and -- sin-1 (t2 / t3) -- calculating -- peak detecting signal SP The phase of the output signal Y at the output event is computed.

[0031] Thus, the phase of the computed output signal Y is equivalent to the level of the output signal Y at the time of a focusing point arising in a device under test 16, i.e., the location of an objective lens 15. And the phasing signal S45 which is the result of an operation is outputted from operation part 45, is inputted into the distance transform section 46, changes into distance, and measures the variation rate

of the front face of a device under test 16.

[0032] Moreover, the digital value which carried out analog-to-digital conversion of the peak value of the light-receiving output of the data of distance and photo diode 18 which were changed in the distance transform section 46 is matched, and it is the peak detecting signal SP. It inputs into memory 47 to timing, and memory 47 memorizes. That is, as mentioned above, when the output signal X which two peaks produced in few time difference is outputted by the irregularity of the front face of a device under test 16, memory 47 is made to memorize also about the digital value which carried out analog-to-digital conversion of the value of each peak, and the value of the distance corresponding to the peak.

[0033] And based on the content of storage of this memory 47, the data judging section 48 judges whether the value of the distance corresponding to which peak supports the distance from the criteria location of optical system to a device under test 16. First, the wave form chart of the output signal X shown with the flow chart of drawing 3 and the measurement condition of drawing 4 explains the case where a device under test 16 is the non-translucency like a metal, and a front face is a concavo-convex field.

[0034] Drawing 4 makes an axis of ordinate the level of an output signal X, and is taken as the value of the distance which changed the horizontal axis. Thus, when the variation rate of the front face of the device under test 16 of non-translucency is measured, and it is projected on light and reflects in the flat side of the front face of a device under test 16, it is drawing 4 (a). The level difference of a peak with level high to the 1st and a peak high to the 2nd is set to Q so that it may be shown. Moreover, when it is projected on light and reflects in fields other than the flat side of the front face of a device under test 16, it is drawing 4 (b). So that it may be shown There are few differences of the level of a peak with level high to the 1st and the level of a peak high to the 2nd, and the level difference becomes Q', or it is drawing 4 (c). So that it may be shown Level of a peak with level high to the 1st, The case where become Q " of differences with the level of a high peak, and the difference becomes smaller the 2nd may happen.

[0035] Then, if the data distinction section 48 distinguishes whether it is more than the predetermined level LV that the peak with level high to the 1st among the peaks of the output signal X acquired in the oscillating half period of an objective lens 15 has defined beforehand (S1) and distinguishes more than from the predetermined level LV, the level difference of a peak with level high to the 1st and a peak with level high to the 2nd will distinguish continuously whether it is beyond a predetermined value (S2). If it distinguishes beyond from a predetermined value here, it will judge that the distance corresponding to a peak with level high to the 1st supports the distance from the criteria location of optical system to a device under test 16 (S3), and the value of the distance corresponding to the peak will be made into measured value (S4). In addition, when a peak with level high to the 1st distinguishes below predetermined level (S1), or when the difference of a peak distinguishes below a predetermined value, (S2) and measured value are not updated (S5). Thus, when the level difference of a peak is beyond a predetermined value, the value of the distance at the time of the peak to the 1st with large level being acquired is measured, and

even if the front face of a device under test 16 is a concavo-convex field, a surface variation rate can be measured to accuracy.

[0036] Next, a device under test 16 is the translucency like glass, and the wave form chart of the output signal X shown with the flow chart of drawing 5 and the measurement condition of drawing 6 explains the case where the variation rate of the front face is measured. Drawing 6 makes an axis of ordinate the level of an output signal X, and is taken as the value of the distance which changed the horizontal axis. In the case of such a device under test 16, it is drawing 6 (a). The reflected light L1 reflected on the front face and base of a device under test 16 so that it might be shown, and L2 Drawing 6 (b) It is a peak P1 and P2 at the half period of an oscillation of an objective lens 15 so that it may be shown. An output signal X is acquired. Then, the peak P1 of an output signal X and P2 Inside, if a peak with level high to the 1st distinguishes whether it is more than the predetermined level LV defined beforehand (S1) and distinguishes more than from the predetermined level LV, a peak with level high to the 2nd will distinguish continuously whether it is more than the predetermined level LV (S2). If it distinguishes more than from predetermined level here, what has the small value of distance will be judged in the distance from the criteria location of optical system to a device under test 16 to be a response (S3).

[0037] And the value of the distance corresponding to the peak is made into measured value (S4). Thereby, the variation rate of the front face of a device under test 16 can be measured to accuracy. Here, it is drawing 6 (c) to the front face which should measure a device under test 16. When Dust Z has adhered so that it may be shown, it is drawing 6 (c). It is the reflected light L1 from the front face of a device under test 16 so that it may be shown. It is a peak P1 by having decreased. Level falls. On the other hand, it is the reflected light L2 from the base of a device under test 16. It does not decrease but is drawing 6 (d). It is the peak P1 with level high to the 2nd so that it may be shown. It becomes below the predetermined level LV.

[0038] Therefore, when Dust Z has adhered, a peak with level high to the 1st distinguishes more than from the predetermined level LV (S1), it distinguishes whether there is any peak with level high to the 2nd continuously more than predetermined level (S2), it distinguishes below the predetermined level LV, and measured value is not updated (S5). Thus, the variation rate of the front face of the device under test 16 of translucency can be measured to accuracy. In addition, when what has the large value of distance is judged in a step (S3) in the distance from the criteria location of optical system to a device under test 16 to be a response, the variation rate of the base of a device under test 16 can be measured to accuracy like a surface variation rate.

[0039] Next, the device under test 16 has the paint film which applied the adhesives of translucency on the surface of the metal, and explains by the wave form chart of the output signal X shown with the flow chart of drawing 7 , and the measurement condition of drawing 8 about the case where the variation rate of the front face of the paint film is measured. Drawing 8 makes an axis of ordinate the level of an output signal X, and is taken as the value of the distance which changed the horizontal axis. the case of such a device under test 16 -- drawing 8 (a) The reflected light L3 reflected on the front face of the paint film of a device under test 16, and the metaled front

face so that it might be shown And L4 Drawing 8 (b) it is shown -- as -- peak P3 And peak P4 from -- the becoming output signal X is acquired.

[0040] The peak which has the level of the peak acquired in the half period of an oscillation of an objective lens 15 here more than the predetermined level LV defined beforehand is extracted (S1). Then, in the extracted peak, the value of distance data judges the minimum distance data in the distance from the criteria location of optical system to a device under test 16 to be a response (S2), and makes the value of the distance measured value (S3). Thereby, the peak by the reflected light from a metaled front face and the peak by the reflected light from the front face of a paint film are distinguished, and the variation rate of the front face of the paint film applied on the surface of the metal can be measured to accuracy.

[0041]

[Effect of the Invention] As explained in full detail above, according to the 1st invention, the light-receiving output level of a light sensing portion, The storage section is made to memorize the distance data from the criteria location of the optical system acquired based on the location of a light-receiving output level and an objective lens to a device under test. When the light-receiving output maximum of the light sensing portion obtained in the half period of an oscillation of an objective lens is more than predetermined level and the difference of light-receiving output maximum and the light-receiving output following order value is beyond a predetermined value Since the distance data corresponding to light-receiving output maximum was judged to be measurement data, even if two peaks are acquired by few time difference with the irregularity of the front face of a device under test, the displacement gage which can measure the variation rate of the front face of a device under test to accuracy can be offered.

[0042] According to the 2nd invention, the storage section is made to memorize the light-receiving output level of a light sensing portion, and the distance data from the criteria location of the optical system acquired based on the location of a light-receiving output level and an objective lens to a device under test. When both the light-receiving output maximums of a light sensing portion and light-receiving output following order values in the half period of an oscillation of an objective lens are more than predetermined level Since distance [with a small or numeric value] data with a large numeric value was judged to be measurement data, the displacement gage which can measure the variation rate of the front face of the device under test of translucency or a base to accuracy, without receiving the effect of the dust adhering to a front face can be offered.

[0043] According to the 3rd invention, obtained based on the location of the light-receiving output level of a light sensing portion, a light-receiving output level, and an objective lens. The storage section is made to memorize the distance data from the criteria location of optical system to a device under test. The light-receiving output of the light sensing portion in the half period of an oscillation of an objective lens extracts the thing more than predetermined level. Since the numeric value judged the minimum distance data out of the extracted light-receiving output maximum and corresponding distance data to be measurement data, the reflected light from the front face of a non-translucency body, The reflected light from the front

face of the translucency body formed in the front face of the non-translucency body is distinguished, and the displacement gage which can measure the variation rate of the front face of a translucency body to accuracy can be offered.